

A SURVEY OF THE HELMINTH PARASITES
OF SMALL MAMMALS IN THE VICINITY
OF MANHATTAN, KANSAS

by

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TABLE OF CONTENTS

INTRODUCTION.....	1
REVIEW OF LITERATURE.....	2
METHODS AND PROCEDURES.....	4
CLASS CESTODA.....	10
Family Anoplocephalidae Fuhrmann, 1907.....	10
<u>Andrya macrocephala</u> Douthitt, 1915.....	10
<u>Paranoplocephala variabilis</u> Douthitt, 1915.....	12
<u>Paranoplocephala borealis</u> Douthitt, 1915.....	15
<u>Paranoplocephala</u> spp. Lühe, 1910.....	17
<u>Cittotaenia pectinata americana</u> Douthitt, 1915.....	17
<u>Cittotaenia variabilis</u> (Stiles, 1895) Stiles and Hassall, 1896.....	18
Family Hymenolepididae Fuhrmann, 1907.....	19
<u>Hymenolepis diminuta</u> (Rudolphi, 1819) Blanchard, 1891.....	19
<u>Hymenolepis anthocephalus</u> Van Gundy 1935.....	20
<u>Hymenolepis</u> spp. Weinland, 1858.....	22
Family Taeniidae Ludwig, 1886.....	22
<u>Cysticercus fasciolaris</u> Rudolphi, 1808.....	22
<u>Cysticercus pisiformis</u> (Bloch, 1780) Zeder, 1803.....	23
Family Dilepididae Fuhrmann, 1907.....	23
<u>Choanotaenia</u> sp. Railliet, 1896.....	23
<u>Choanotaenia</u> sp. Railliet, 1896.....	23

CLASS NEMATODA.....	27
Family Oxyuridae Cobbold, 1864.....	27
<u>Syphacia obvelata</u> Rudolphi, 1802.....	27
<u>Syphacia peromysci</u> Harkema, 1936.....	29
<u>Dermatoxys veligera</u> Rudolphi, 1819.....	32
<u>Aspiculuris tetraptera</u> Nitzsch, 1821.....	33
Family Trichuridae Railliet, 1915.....	35
<u>Trichuris sylvilagi</u> Tiner, 1950.....	35
<u>Trichuris</u> sp. Roederer, 1761.....	37
Family Thelaziidae Railliet, 1916.....	38
<u>Rictularia coloradensis</u> Hall, 1916.....	39
Family Spiruridea Oerley, 1885.....	41
<u>Gongylonema</u> sp. Molin, 1857.....	42
Family Heterakidae Railliet and Henry, 1914.....	45
<u>Heterakis spumosa</u> Schneider, 1866.....	45
CLASS TREMATODA.....	49
Family Dicrocoeliidae Odhner, 1910.....	49
<u>Eurytrema</u> sp. Looss, 1907.....	49
Family Brachylaemidae Joyeux and Foley, 1930.....	51
<u>Itygonimus</u> sp.(?) Lühe, 1899.....	51
ECOLOGY.....	53
SUMMARY.....	58
ACKNOWLEDGMENTS.....	60
REFERENCES.....	61
APPENDIX.....	65

INTRODUCTION

The economic and ecological importance of small mammals, especially of the orders Rodentia and Lagomorpha, as host animals for a wide variety of parasites and infectious diseases, has received in recent years an increasing and widespread interest among the various workers in these fields. While animal parasites are not usually fatal they may lessen the vitality of the host permitting serious inroads of infectious diseases. Therefore, a thorough knowledge of the helminth parasites in these animals, which serve as primary food sources for many carnivores, is desirable. While the material dealing with these parasites is steadily becoming more extensive, there yet remains a vast amount of research to be conducted in order that many points of controversy concerning proper recognition and taxonomic placement of these species may be clarified. Also, further investigation will aid in the advancement of the knowledge concerning the ecological relationships existing between parasites and their host animals.

Recently an opportunity presented itself at Kansas State College for a survey to be made of the helminth parasites of small mammals. Drs. Gier and Tiemeier of the Kansas State Zoology Department, who have been conducting an ecological study of rodents in recent years, made available for helminthological study a considerable number and variety of rodent

species to supplement the writer's own trapping yields. Since no survey of the parasites of rodents has as yet been undertaken in Kansas, it was felt that the availability of these animals afforded an excellent opportunity to contribute to the knowledge of the helminth fauna of small mammals in Kansas.

The following animals were examined for parasitic helminth infections: Baird's white-footed mouse Peromyscus maniculatus bairdii Hoy and Kennicott; the white-footed mouse P. leucopus noveboracensis Fisher; the prairie meadow vole Microtus ochrogaster ochrogaster Wagner; the house mouse Mus musculus musculus Linnaeus, the Norway rat Rattus norvegicus Erxleben; Mearn's cottontail rabbit Sylvilagus floridanus mearnsi Allen; the cotton rat Sigmodon hispidis texanus Audubon and Bachman; the harvest mouse Reithrodontomys albescens griseus Bailey, and R. megalotus dychei Allen; the lemming mouse Synaptomys cooperi gossi Coues; the large short-tailed shrew Blarina brevicauda brevicauda Say; the western fox squirrel Sciurus niger rufiventer Geoffroy; Shaw's pocket gopher Geomys bursarius bursarius Shaw; and the pocket mouse Perognathus hispidus spilotus Merriam.

REVIEW OF LITERATURE

Animals of the orders Rodentia and Lagomorpha, because of their cosmopolitan distribution, comparative ease of capture and abundance in numbers and species, were among the first animals to be studied for parasitic infections.

According to Hansen (1948), Goeze in 1782 described a tapeworm now known as Cittotaenia pectinata (Goeze) from the European hare. Since that time many new species of rodent helminths have been recorded by various workers. Stiles (1897) published a revision of the cestodes of hares and rabbits of the world. Douthitt (1915) and Baer (1927) wrote extensive monographs of the cestode family Anoplocephalidae, many species of which are parasitic in rodents, while Joyeux and Baer (1936) reviewed the cestode fauna of France. Hall (1916) monographed the nematodes of mammals of the orders Rodentia, Lagomorpha, and Hydracoidea, in which he described 34 species from North American rodents including 11 new species. Yorke and Maplestone (1926) include in their exhaustive work on the "Nematode Parasites of Vertebrates" a list, to date of publication, of all known species of parasitic nematodes. Meggitt (1924) reported on the cestodes of mammals and included in his monograph a list of all known cestodes of these animals.

More recent contributions have been by Oldham (1931), who listed the known helminth parasites of three common species of rats, together with distribution, references to literature, and remarks on the parasites. A thorough review was published by Harkema (1936) in which he surveyed the parasites of the Rodentia and Lagomorpha, giving inclusive listings of all known helminths, protozoa and arthropods of these orders. Rausch and Tiner (1949) reported on an ecological survey of

the helminths parasitic in the meadow vole (Microtus spp.) of the North Central States. Another publication which warrants reference is Erickson's host catalogues of helminth parasites of native American mice and rabbits of the genus Sylvilagus published in 1938 and 1946.

The literature cited above, while including the more pertinent references on small mammal helminths, constitutes only a relatively small part of the literature available on this subject. The greater number of publications were found to be scattered in many periodicals and consisted usually of the description of one or a few species, many of which were found applicable to this paper and are, therefore, recorded in its bibliography.

METHODS AND PROCEDURES

Three hundred and fifty-six small mammals comprising 10 genera and 12 species of the order Rodentia, one species of the order Insectivora, and one species of Lagomorpha, were examined for parasitic helminth infections (Table 1). With the exclusion of the lagomorphs and sciurids, these animals were obtained through the use of the usual snap-type mouse traps. The traps were baited with an oatmeal-peanut butter mixture and whenever possible were set in runways or openings of burrows where they proved very effective. Snap-door live traps fashioned from tin cans to which a mouse trap had been attached to the open end, were

also employed with excellent results. In the case of shrews and harvest mice however, it was found that there was no advantage in live trapping over the snap-trap method because these animals invariably succumbed by the time collections were made. Hansen (1948) attributed this phenomenon to the wide fluxuations in temperature of the metal traps which proved lethal to these fragile animals. Having employed snap-door wooden live traps he found these to maintain a much more constant temperature with the changing weather conditions, and consequently proved less fatal to the imprisoned animal than the metal type. In addition, Devoe (1951) pointed out that due to the extremely nervous and delicate disposition of shrews, they frequently die instantly when caught in one's hand. Squirrels and rabbits examined were obtained in the field with the aid of a 22 calibre pistol. The trapping was done from September to May of 1951 and 1952, with the exclusion of December and January when it was found impractical due to weather conditions. The traps were set within a six mile radius of Manhattan, Kansas with the object of obtaining as wide a variety of mammal species as possible. Some animals were received and examined from outside this area. The sets were inspected every 24 hours. Identification of animals was made early in the study by Drs. Tiemeier and Gier and later by the writer as he became acquainted with the characteristic taxonomic features of these animals.

Post-mortems were performed usually as soon after capture

as possible. In some cases, when animals were received from a distance, it was impossible to examine them until several days after capture. In spite of the time that had elapsed most of the helminths recovered were still alive, and proper fixation was obtained in most cases.

An incision was made along the full length of the ventral surface of the body, and the stomach, intestines, liver, kidneys, heart and lungs were excised and placed in petri dishes containing tap water. The lungs, liver, kidneys and heart were then teased apart with dissecting needles and were observed for helminth infection. The stomach and intestines were cut longitudinally, washed and scraped to secure thorough cleaning, and the contents examined under a binocular dissecting microscope. All helminths were placed in saline solution immediately after removal from their hosts preparatory to fixation. Nematodes were fixed by placing them in 70 per cent alcohol which had been previously heated to slightly below the boiling point. All cestodes were placed in a petri dish with tap water and kept in a refrigerator at 40°F. for from 5 to 10 hours at which time they were found in a relaxed condition and suitable for proper fixation. Trematodes were fixed by placing each specimen on a slide and orienting it in a drop of tap water. A cover-slip was then placed on the specimen and by means of absorbent toweling the water was drawn out from under the cover-slip from one side, while the fixative, in this case A.F.A., was added to the opposite side.

All nematodes and trematodes were stored in 70 per cent alcohol, while cestodes after relaxation were stored in a solution of the following formula.

Alcohol 95%	24 cc
Formaldehyde	15 cc
Acetic acid	5 cc
Glycerine	10 cc
Water	46 cc

Delafield's haematoxylin was found to be a very satisfactory stain for cestode and trematode toto-mounts. All specimens of these helminths were stained in an aqueous solution of Delafield's at a ratio of approximately 1 part stain to 35 parts tap water. The specimens were allowed to remain from 2 to 6 hours in the stain solution depending on their size and thickness. The flatworms were then dehydrated to 70 per cent alcohol where they were first destained in a weak acid solution for from 1 to 5 minutes, and then placed in a dilute ammonium hydroxide solution for "bluing up". Upon further dehydration the specimens were arranged on slides moistened with 95 per cent alcohol. Cover-slips were then placed on top of the specimens and the slides put in a petri dish and covered carefully with 95 per cent alcohol. Large and twisted specimens were weighted to flatten them and allowed to remain in this condition over night. The specimens were then placed in absolute alcohol, (two changes), to insure complete dehydration. Several clearing agents were employed but best

results were obtained with beechwood creosote. This process consumed one to several hours after which the specimens were washed in xylol and mounted in piccolyte. Beechwood creosote was found superior to xylol and methyl salicylate, (oil of wintergreen), for clearing cestodes because the specimens did not become hard and brittle during clearing and could easily be oriented on the slide without breakage. Satisfactory results were achieved, however, by employing xylol and oil of wintergreen in clearing trematodes, as these helminths are more easily handled than cestodes and do not usually twist or break up in the process of mounting. Nematodes were cleared in 70 per cent alcohol with the gradual addition of lactophenol until the specimen was finally cleared in 100 per cent lactophenol. They were stored in glycerine until needed.

A useful technique was employed in making semi-permanent nematode mounts in glycerine. This was accomplished simply by placing the cleared specimen in glycerine on a slide, covering with a cover-slip and ringing the edges of the cover-slip with slide-ringing cement or piccolyte to guard against evaporation. This technique eliminates the necessity of washing and dehydrating stored specimens to make permanent mounts, and is advantageous in that the mount is durable for many months and also allows the worker to recover the specimen at some future date for further study.

Table 1. Hosts and their helminth parasites based upon collections in Kansas.

Host and helminth parasite(s)	: Hosts examined : number	: Hosts infected : number	: Infected : %	: Helminths per host : maximum number
<u>Microtus ochrogaster ochrogaster</u> (Prairie meadow vole)	80			
<u>Andrya macrocephala</u>		15	18.5	2
<u>Paranoplocephala variabilis</u>		18	22.5	7
<u>Paranoplocephala borealis</u>		3	3.8	3
<u>Paranoplocephala sp.</u>		3	3.8	9
<u>Hymenolepis sp.</u>		1	1.3	1
<u>Syphacia obvelata</u>		19	23.8	127
<u>Trichuris sp.</u>		1	1.3	1
<u>Gongylonema sp.</u>		2	2.5	6
<u>Sigmodon hispidus texanus</u> (Cotton rat)	18			
<u>Paranoplocephala sp.</u>		1	5.6	1
<u>Hymenolepis sp.</u>		1	5.6	1
<u>Mus musculus musculus</u> (House mouse)	13			
<u>Cysticercus fasciolaris (larva)</u>		1	7.6	1
<u>Syphacia obvelata</u>		3	25	29
<u>Aspicularis tetraptera</u>		2	15.3	19
<u>Eurytrema sp.</u>		1	7.6	5
<u>Peromyscus maniculatus bairdii</u> (White-footed mouse)	136			
<u>Cheanotaenia sp.</u>		1	0.73	1
<u>Syphacia peromysci</u>		8	5.7	47
<u>Rictularia coloradensis</u>		6	4.4	2
<u>Gongylonema sp.</u>		1	0.73	6
<u>Peromyscus leucopus noveboracensis</u> (White-footed mouse)	7			
<u>Hymenolepis sp.</u>		1	14.3	1
<u>Rictularia coloradensis</u>		2	28.7	1
<u>Rattus norvegicus</u> (Norway rat)	5			
<u>Hymenolepis diminuta</u>		1	20	8
<u>Cysticercus fasciolaris (larva)</u>		4	80	3
<u>Heterarcis spumosa</u>		1	20	6
<u>Blarina brevicauda brevicauda</u> (Large short-tailed shrew)	37			
<u>Hymenolepis anthocephalus</u>		5	13.5	5
<u>Itygonimus sp. (?)</u>		6	16.6	9
<u>Sylvilagus floridanus mearnsi</u> (Cottontail rabbit)	8			
<u>Cittotaenia pectinata americana</u>		5	62.5	2
<u>Cittotaenia variabilis</u>		2	25	1
<u>Cysticercus pisiformis (larva)</u>		3	37.5	2
<u>Trichuris sylvilagi</u>		2	2.5	2
<u>Dermatoxys veligera</u>		3	37.5	5

CLASS CESTODA

Family Anoplocephalidae Fuhrmann, 1907

Proglottids generally wider than long; scolex with neither rostellum nor hooks; genital pores marginal and frequently irregularly alternate; testes numerous; uterus tubular, pyriform or sacciforme; vagina situated posterior to cirrus sac; genital ducts passing dorsal to ventral excretory vessel; eggs bearing a pyriform apparatus; adults in birds, reptiles and mammals.

Andrya macrocephala Douthitt, 1915

Of 80 prairie meadow voles (Microtus ochrogaster ochrogaster Wagner) examined, 15 were found infected with Andrya macrocephala.

Description: The strobila measures 180 to 278 mm long by 2.08 to 2.88 mm wide. The scolex is 1.18 to 1.65 mm long by 0.87 to 1.21 mm wide. The suckers are well developed and muscular measuring 0.442 mm in diameter, while the sucker orifice measures 0.217 mm. A neck is present measuring 1.28 mm in length. The genital pores are irregularly alternate with the exception of one specimen which exhibited unilateral pores. The genital pores in mature proglottids open approximately two-thirds to three-fourths the length of the lateral margin from the anterior end of the proglottid. The ventral excretory vessel is 0.059 to 0.129 mm in width but averages

0.095 mm.

The testes vary in number from 19 to 28; they are slightly ovoid and measure 0.034 to 0.082 mm in diameter. They are located in the aporal half of the proglottid for the most part, but occasionally overlap into the poral half, not reaching the midline of the ovary. The testes are located dorsal to the ventral excretory canal and extend beyond it aporally. The cirrus sac measures 0.283 to 0.326 mm in length by 0.068 to 0.095 mm in width.

The ovary, located mostly in the poral half of the segment, but extending in some cases into the aporal half, is a multilobed, fanshaped structure measuring 0.618 to 0.748 mm in length and 0.258 to 0.299 mm in width. It is composed of from 21 to 28 lobes. The seminal receptacle measures 0.217 mm in length by 0.102 mm in width in mature proglottids. It extends beyond the ventral excretory vessel on the poral side tapering acutely into the vagina. The vagina is posterior to and on the same level as the cirrus sac. The vitellarium is a lobed kidney-shaped structure lying within the posterior limits of the ovary and dorsal to them. A shell gland is present. The uterus is reticular at first but later develops anterior and posterior out-pocketings; it is ventral to and extends beyond the ventral excretory vessels laterally. The eggs are 0.030 to 0.042 mm in diameter. A pyriform apparatus containing an onchosphere is present measuring 0.023 mm in length, while the onchosphere

measures 0.012 to 0.135 mm.

Host: Microtus ochrogaster (Wagner)

Habitat: Small Intestines

Locality: Manhattan, Kansas

Discussion: Rausch and Schiller (1949) invalidated the use of testes number and distribution, along with ventral excretory canal diameter as criteria in determining species of Andrya unless they occur in combination with other characteristics which are relatively constant. In the case of A. macrocephala, more attention is given to egg size, and testes overlapping the longitudinal excretory canal on the aporal side only. Two species of Andrya, A. microti Hansen (1947) and A. ondatre Rausch (1948) are, therefore, reduced to synonymy and designated A. macrocephala under these revised criteria. On the examination of several specimens of this genus, there was found several distinct variations (Table 2) from the three above mentioned species. However, the variations of the writer's specimens with those criteria which now validate identification as A. macrocephala, are not considered great enough to warrant the naming of a new species. These specimens are, therefore, reported as A. macrocephala until further data are available.

Paranoplocephala variabilis Douthitt, 1915

Eighteen of 80 prairie meadow voles in the vicinity of Manhattan, Kansas were found to be infected with the cestode

Table 2. A comparative study of the species of Andrya reported synonymous with A. macrocephala Douthitt (1915).

Description	<u>Andrya macrocephala</u> : Douthitt, 1915	<u>Andrya microti</u> : Hansen, 1947	<u>Andrya ondatre</u> : Rausch, 1948	<u>Andrya macrocephala</u> : (this paper)
Total length	100 to 200 mm	90 to 200 mm	155 mm	180 to 278 mm
Total width	1.5	1.710 to 2.09	3.0	2.08 to 2.88
Scolex) Length	0.700 to 0.950	0.790 to 1.03	0.680	1.18 to 1.65
) Width	0.600 to 0.800	0.850 to 1.26	0.580	0.870 to 1.21
Sucker diameter	0.300	0.310 to 0.490	0.250	0.440
Neck length	1.5	0.690 to 1.0	0.700	1.28
Diameter of ventral excretory vessel	0.320	0.025 to 0.041	0.085	0.059 to 0.129
Cirrus) Length	0.155	0.178 to 0.233	0.213 to 0.224	0.283 to 0.326
pouch) Width	0.075	0.055 to 0.069	0.113 to 0.122	0.068 to 0.095
Testes) Number	43 to 57	28 to 35	75 to 95	19 to 28
) Size	0.05	0.041 to 0.069	0.066 to 0.085	0.034 to 0.082
Seminal) Length	—	0.342	0.278	0.217
receptacle) Width	—	0.145	0.118	0.102
Vagina position	Posterior to cirrus sac	Posterior to cirrus sac	Posterior to cirrus sac	Posterior to cirrus sac
Ovary) Length	—	0.247 to 0.575	0.560 to 0.780	0.618 to 0.748
) Width	—	0.164 to 0.274	0.140 to 0.340	0.258 to 0.299
Eggs	0.030 to 0.032	0.032 to 0.033	0.033 to 0.039	0.030 to 0.042

species Paranoplocephala variabilis.

Description: The total length is 27 to 68 mm (these measurements include both contracted and fully expanded specimens). The maximum width is 2.5 to 3.6 mm. The scolex measures 0.184 to 0.380 mm in length by 0.319 to 0.460 mm in width. The longitudinal excretory vessel is 0.023 mm in diameter. The genital pores are unilateral and situated laterally two-thirds of the distance from the anterior end of the segment. The testes are spherical, 35 to 63 in number and measure 0.028 to 0.056 mm. They extend aporally across the longitudinal excretory canal. The cirrus sac is elongate 0.095 to 0.238 mm in length, and does not extend across the longitudinal excretory canal porally. The cirrus is aspinose. The vagina opens posterior to the cirrus sac. The ovary is fanshaped with 32 to 42 finger-like projections, and is situated toward the poral half of the segment. The uterus is tubular in mature proglottids becoming sacculate in gravid proglottids. The eggs measure 0.027 to 0.035 mm in diameter and possess a well developed pyriform apparatus.

Host: Microtus ochrogaster Wagner

Habitat: Duodenum

Locality: Manhattan, Kansas

Discussion: In the description of the above specimens some of the more notable morphological variations evidenced from those of Douthitt (1915) and Rausch and Schiller (1949) are fewer testes, a larger cirrus sac, and longer length of

the specimens. According to these workers variations are to be expected among cestodes which have been fixed in a relaxed condition and cestodes which have been fixed in a contracted condition. As in Andrya macrocephala (this paper), more attention is given to egg size and testes overlapping the longitudinal excretory canal on the aporal side. The majority of variations of the material studied in this survey are concluded to be due to the state in which the cestodes were fixed, and/or to the particular locality in which they were found.

Paranoplocephala borealis Douthitt, 1915

Six specimens of the cestode species Paranoplocephala borealis were recovered from 3 prairie meadow voles in the vicinity of Manhattan, Kansas.

Description: The length of the adult worms is 9.1 to 17.1 mm. The maximum width is 0.782 to 1.95 mm. Proglottids are 51 to 84 in number, much wider than long (ratio of length to width in mature segments, 1:4). The scolex measures 0.279 to 0.299 mm long by 0.299 to 0.353 mm wide. The ventral longitudinal excretory canal measures 0.014 mm in diameter. The genital pore is unilateral, and is situated near the middle of the margin of the proglottid. Testes are ovoid, from 35 to 45 in number and reach a diameter of 0.031 mm. They extend from the middle of the segment to well across the aporal longitudinal excretory canal. The cirrus sac

is elongate, 0.153 mm in length by 0.014 mm in width. It extends beyond the longitudinal excretory canal porally. The cirrus is aspinose. The vagina opens posterior to the cirrus sac. The ovary is centrally located tending toward the poral aspect of the segment. It is strongly lobed. The vitelline gland is located dorsal to and posterior to the ovary and is kidney-like in shape. The uterus is tubular becoming sacculate in gravid segments. Although these specimens were considered to be complete in their segment complement, as was determined by the presence of saccular uteri and a narrowing of the extreme posterior end, there were no mature eggs noted by the writer.

Host: Microtus ochrogaster Wagner

Habitat: Small intestines

Locality: Manhattan, Kansas

Discussion: Rausch and Schiller (1949) in their studies of the voles of the North Central States, found P. variabilis borealis Douthitt (1915) which was previously recorded as a subspecies of P. variabilis, to be a distinct species. The writer after having examined material from both species, felt the elevation of P. borealis to full specific rank to be justified, due primarily to the distinctive variations noted in the lengths, and the length-width ratios of single proglottids in specimens which were fixed under identical relaxed conditions.

Paranoplocephala spp. Luhe, 1910

An additional 16 cestode specimens comprising probably two separate species of the genus Paranoplocephala Luhe, 1910 were encountered during routine examinations of the intestines of small mammals. Of these 15 were recovered from the prairie meadow vole, and one specimen was recovered from the cotton rat, Sigmodon hispidus hispidus Say and Ord.

A tentative specific identification of these cestodes was all that was possible, due to lack of complete specimens in some cases, and failure to obtain proper fixation in others. These tapeworms, however, were found to possess the taxonomic characteristics of the genus Paranoplocephala, and were, therefore, so designated.

Cittotaenia pectinata americana Douthitt, 1915

Of 8 cottontail rabbits, Sylvilagus floridanus mearnsi Allen, collected at Manhattan, Kansas, five harbored this species of tapeworm.

Description: Mature specimens are 116 mm long and 8.8 mm wide. Each segment possesses a double set of reproductive organs. The scolex is 0.240 mm wide and 0.136 mm long. Suckers are situated close together and measure 0.098 mm in diameter. The neck region is short and broad 0.327 mm in diameter. The proglottids are much broader than long and number approximately 143. The ovaries measure in mature segments 0.537 mm in width. The eggs are 0.068 mm in

diameter and contain a well developed pyriform apparatus. The testes approximate 90 per segment and are situated in the distal half of the proglottids. The testes are distributed laterally in the distal part of the segment, the medial area being devoid of testes. The cirrus sac is 0.369 mm long and extends medially beyond the longitudinal excretory canal.

Host: Sylvilagus floridanus mearnsi Allen

Habitat: Duodenum

Locality: Manhattan, Kansas

Cittotaenia variabilis (Stiles, 1895) Stiles and Hassall, 1896

Two specimens of C. variabilis were recovered from the cottontail rabbit.

Description: Mature specimens are approximately 540 mm long by 5.91 mm wide. A double set of reproductive organs is present in each segment. The scolex is 0.598 mm in width and is continuous with the neck. Suckers measure 0.252 mm in diameter. The neck is well defined and is 0.456 mm in length. The uterus is tubular. The eggs measure 0.065 mm in diameter and possess a well developed pyriform apparatus. Testes are located in the distal half of the segment between the two ovaries and number approximately 80 to 115. Seminal receptacle is medial to the longitudinal excretory canal. The vagina opens immediately posterior to the cirrus sac.

Host: Sylvilagus floridanus mearnsi Allen

Habitat: Small intestines

Locality: Manhattan, Kansas

Discussion: Both of the above species of Cittotaenia have been previously reported from Kansas. The material studied in this survey was found to be essentially identical with that previously described, and hence no further elaboration was considered necessary.

Family Hymenolepididae Fuhrmann, 1907

Medium-sized or small worms, segments usually broader than long; scolex usually with a single row of hooks, but unarmed in H. diminuta; ripe uterus sac-like, not breaking up into egg balls; genital pores lateral, usually all on one side; ovary and yolk gland near center of proglottid and with 1 to 4 testes.

Hymenolepis diminuta (Rudolphi, 1819) Blanchard, 1891

Eight specimens of the cestode species, Hymenolepis diminuta, were recovered from the Norway rat, Rattus norvegicus Erxleben, near Manhattan, Kansas.

Description: The total length is approximately 348 mm. The scolex measures 0.150 mm and is unarmed. Suckers have an average diameter of 0.096 mm. The testes are three in number and are arranged in a line in the distal aspect of the segment. The cirrus sac in mature segments measures

0.187 mm in length and 0.039 mm in width. The uterus is sacciform. Eggs are 0.057 mm long by 0.039 mm wide.

Host: Rattus norvegicus Erxleben

Habitat: Small intestine

Locality: Manhattan, Kansas

Hymenolepis anthocephalus Van Gundy, 1935

Of 37 short-tailed shrews, Blarina brevicauda brevicauda Say, examined for helminth infection near Manhattan, Kansas, five were found harboring the tapeworm Hymenolepis anthocephalus.

Description: The total length is approximately 45.4 mm long, and the greatest width is obtained in gravid segments, 0.496 mm. The segments are wider than long, but fully gravid segments are nearly square. The scolex measures 0.197 mm in diameter and contains muscular suckers which measure approximately 0.095 mm in diameter. The scolex is unarmed and presents a flower-like appearance which is characteristic of this species. The ventral excretory canal is 0.011 mm in diameter, while the dorsal canal, situated lateral to the ventral canal, measures 0.004 mm. No transverse excretory canals are visible. Genital pores are unilateral, situated one-third the distance of the lateral margin from the anterior end of the segment. The cirrus sac is 0.097 mm long by 0.033 mm wide in mature segments. The cirrus is spinose. The testes in mature segments measure 0.052 mm in diameter and are situated two aporally and one porally in an L-shaped pattern in the

proglottid. The ovary is roughly lobulate to tri-lobed, measuring 0.078 mm in diameter and is situated centrally and anterior in the segment. The vitelline gland is posterior to the ovary. The uterus in gravid segments fills most of the area between the excretory canal and is reticulate in appearance, becoming dendritic with age although retaining a bi-winged appearance. Eggs are spherical, 0.033 mm in diameter, and possess a well developed hexacanth embryo.

Host: Blarina brevicauda brevicauda Say

Habitat: Small intestines

Locality: Manhattan, Kansas

Discussion: In the diagnosis of these cestode specimens the writer observed certain minor variations between his material and that of Van Gundy (1935). The scolex, testes, ovaries and ventral excretory canal measured smaller than these structures described by Van Gundy but since the sizes were found to be relative to the size of the adult these variations were not considered significant. Since the specimens examined in this study exhibited such key features as the extremely characteristic flower-like scolex which was well developed and exceedingly globular, and the dendritic uterus which has a characteristic bi-winged appearance, a definite diagnosis of H. anthocephalus was made.

Hymenolepis spp. Weinland, 1858

Three additional specimens of Hymenolepis, constituting at least two separate species, were recovered from the small intestines of rodents near Manhattan, Kansas. The host animals included Microtus ochrogaster, the prairie meadow vole, Sigmodon hispidus, the cotton rat and Peromyscus leucopus, the white-footed mouse. Due to incomplete material, poor fixation or improper staining, it was impossible to make specific identifications and a generic designation is, therefore, all that was given these cestodes.

Family Taeniidae Ludwig, 1886

Cysticercus fasciolaris Rudolphi, 1808

Seven encysted strobilocerci were recovered from the surface of the liver of four specimens of the Norway rat, and one specimen of the house mouse, Mus musculus musculus Linnaeus, trapped in the vicinity of Manhattan, Kansas. The larval forms were found to possess scolices armed with from 34 to 38 rostellar hooks measuring from 0.415 to 0.442 mm in length. Upon identification these cysts proved to be Cysticercus fasciolaris Rudolphi, 1808, the immature stage of Taenia taeniaformis Batsch, 1786. Since the strobilocerci of this cestode have been found cosmopolitan in field rodents by numerous workers, a detailed discussion in this paper was felt to be unnecessary.

Cysticercus pisiformis (Bloch, 1780) Zeder, 1803

Six specimens of Cysticercus pisiformis, the larval stage of Taenia pisiformis, were recovered from the livers and mesenteries of the cottontail rabbit, S. floridanus. This species is of common and wide spread occurrence and has been discussed in detail by numerous workers.

Family Dilepididae Fuhrmann, 1907

Rostellum usually provided with hooks; suckers unarmed; genital organs single or double; testes numerous; uterus sac-like or branched; true parenchymal egg capsules.

Choanotaenia sp. Railliet, 1896.

Of 136 white footed mice Peromyscus maniculatus bairdii Baird, examined from the vicinity of Manhattan, Kansas, one was found infected with a species of the cestode genus Choanotaenia Railliet, 1896.

Description: The total length of the mature specimen measures 146 mm. Approximate maximum width is 1.46 mm. The scolex is 0.152 mm long and 0.145 mm wide. The suckers are circular, and muscular with a diameter of 0.081 mm. The rostellum measures 0.057 mm long by 0.053 mm wide and has a crown of 23 or 24 hooks. The hooks are 0.027 mm long. The rostellar pouch measures 0.117 mm in length by 0.049 mm in width. Genital pores are irregularly alternate opening one-fourth of the lateral margin from the anterior end of the

segment. The ventral longitudinal excretory canal measures 0.012 to 0.016 mm in width, while the dorsal vessels measure from 0.008 to 0.009 mm. Both vessels follow a rather sinuous course, the dorsal canal being lateral to the ventral canal.

There are from 27 to 36 post-ovarian, oval testes 0.060 to 0.090 mm long by 0.036 to 0.060 mm wide. The cirrus sac is 0.042 to 0.060 mm long by 0.015 to 0.018 mm wide. The vas deferens is much coiled and passes between the dorsal and ventral excretory canals. The cirrus is aspinose and looped within the cirrus sac. The bilobed ovary is divided into a poral and an aporal lobe by the seminal receptacle and are joined by a narrow isthmus just anterior to the vitellarium. The small poral lobe measures approximately 0.142 mm, while the large aporal lobe approximates 0.258 mm. The vagina lies posterior to the cirrus sac and passes between the dorsal and ventral excretory vessels. Near its median portion the vagina enlarges into a seminal receptacle 0.204 to 0.238 mm long by 0.059 to 0.048 mm wide. The vitellarium is a multilobed somewhat crescent-shaped structure 0.231 mm in length. A spherical Mehlis gland is present. The subspherical eggs measure 0.044 to 0.051 mm in diameter. The hooks in the onchosphere are 0.018 mm in length.

Host: Peromyscus maniculatus bairdii Baird

Habitat: Small intestines

Locality: Manhattan, Kansas

Discussion: After having made a comparative study of the Choanotaenia reported from mammals of North America (Table 3) it was concluded that the variations between these species and the writer's material were too great to warrant any definite specific identification. Outstanding among these variations were the length of the adult tapeworm, size of the scolex, testes diameter, length of cirrus sac, and egg diameter. Occurrence of this genus in only one host animal may indicate an accidental infection. However, the presence of mature adult cestodes with gravid segments seemingly refutes this idea on the grounds that accidental infections are usually accompanied by the absence of eggs from well developed proglottids. These specimens are reported as Choanotaenia sp., since there is insufficient material for further determination.

Choanotaenia sp. Railliet, 1896

An additional four specimens of Choanotaenia were recovered from the small intestines of the white footed mouse, P. maniculatus near Manhattan, Kansas. These specimens closely resembled in general appearance the species previously reported from Peromyscus by Erickson (1938) and from Microtus by Hansen (1950). They were, however, devoid of well developed eggs, the gravid proglottids containing only immature eggs. Their presence in the white footed mouse was thought to be accidental for this reason, and the

Table 3. A comparative analysis of the rodent species of Choanotaenia reported from North America.

Description	: <u>Choanotaenia</u> : <u>nebraskensis</u> : Hansen, 1950	: <u>Choanotaenia</u> : <u>peromysci</u> : Erickson, 1938	: <u>Choanotaenia</u> : <u>spermophili</u> : McLeod, 1933	: <u>Choanotaenia</u> : sp. : This paper
Total length	20.3 to 40.6 mm	45	100	146
Maximum width	—	App. 0.845	1.0	1.46
Scolex	0.294 to 0.397 by 0.265 to 0.368	0.330 by 0.254	less than 0.334	0.152 by 0.145
Suckers	0.120 to 0.157	0.082 to 0.092	0.332	0.081
Rostellum length	0.132 to 0.176 by 0.066 to 0.088	0.133	0.105	0.057 by 0.053
Rostellar pouch	0.221 to 0.309 by 0.088 to 0.132	0.224 to 0.232 by 0.072	0.315 by 0.105	0.117 by 0.049
Hooks) Number	24-25	22-23	23-25	23-24
) Length	0.028 to 0.031	0.032	0.034 to 0.037	0.027
Ventral excretory canal	0.020 to 0.047	—	0.010 to 0.016	0.012 to 0.016
Testes) Number	31-43	to 30	20-25	27-36
) Size	0.033 to 0.066	0.024 to 0.028	0.070	0.060 to 0.090 by 0.036 to 0.060
Ovaries) Number	branched	branched	branched	branched
) Size	0.162 to 0.388	—	0.309 to 0.176	0.142 to 0.258
Cirrus sac	0.067 to 0.117 by 0.020 to 0.033	0.120	0.140	0.042 to 0.060 by 0.015 to 0.018
Seminal receptacle	0.067 to 0.143 by 0.050 to 0.067	0.133 by 0.040	0.067 to 0.166 by 0.020 to 0.083	0.204 to 0.238 by 0.048 to 0.039
Eggs	0.065 to 0.074 by 0.056 to 0.065	0.0536 by 0.012	0.056 to 0.062 by 0.042 to 0.046	0.044 to 0.051 by 0.036 to 0.040

Source: Measurements of reported species taken from Hansen (1950).

specimens were designated simply Choanotaenia sp.

CLASS NEMATODA

Family Oxyuridae Cobbold, 1864

Medium-sized to small worms with three inconspicuous lips; oesophagus with a well developed bulb; males bearing a number of large papillae around the cloacal opening; females usually much larger than males and usually have long tapering tails; vulva situated near the anterior end of the body; eggs usually flattened on one side and development takes place without an intermediate host.

Syphacia obvelata Rudolphi, 1802

Approximately 300 specimens of S. obvelata were recovered from the caecum of the prairie meadow vole Microtus ochrogaster and the house mouse Mus musculus. This nematode was the most common helminth of M. ochrogaster, appearing in 19 out of 80 animals.

Description: Female 3.56 to 4.21 mm long by 0.163 to 0.333 mm thick. The body terminates in a long narrow tip posteriorly. The esophagus, exclusive of the bulb, is 0.222 to 0.259 mm long by 0.042 to 0.048 mm thick. The subglobular esophageal bulb is 0.064 to 0.073 mm long by 0.064 to 0.085 mm wide. The nerve ring is approximately 0.113 to 0.132 mm from the anterior end of the worm. The excretory pore is about 0.469 to 0.550 mm from the anterior end. The anus is

0.521 to 0.743 mm from the tip of the tail. The vulva is situated in the anterior half of the nematode 0.511 to 0.743 mm from the anterior end and is very prominent. The vagina extends posteriorly from the vulva and is 0.162 mm long. Uterine branches do not extend posterior to the anus. The eggs are flattened on one side and measure 0.098 to 0.128 mm long by 0.030 to 0.042 mm wide.

Male 1.34 to 1.39 mm long by 0.100 to 0.122 mm thick. Cervical cuticular inflation 0.096 mm long. Three cuticular mamelons on ventral surface in the posterior half of the worm. The posterior extremity is curved ventrally and the body is cut away ventrally behind the cloaca and suddenly narrows and ends in a long pointed tail. The esophagus, including the bulb is 0.212 mm long by 0.026 mm thick at the widest part. The subglobular esophageal bulb measures 0.056 mm long by 0.047 mm wide. The nerve ring is located 0.038 mm from the anterior end. The spicule is slightly curved and measures 0.086 to 0.087 mm long by 0.006 mm wide at its base. The small gubernaculum situated transversely posterior to the spicule is shaped somewhat like a plough share and is 0.032 to 0.042 mm in length. There are approximately three pairs of anal papillae present, two anteriorly and one posteriorly.

Hosts: Microtus ochrogaster Wagner; Mus musculus Linnaeus

Habitat: Caecum

Locality: Manhattan, Kansas

Discussion: The description given above adheres closely to that of Hall, 1916. This particular nematode species is extremely common in prairie meadow voles, Microtus spp., and has been reported from widely dispersed localities all over the world. Male specimens according to Rausch and Tiner (1949) are reported to be rare (Von Linstow, 1884 and Hall, 1916), while Kirschenblatt 1938 reported that in some cases he found males exceeded females in number. Females were found to be predominant in most infections observed in this survey, but infections were seldom encountered where males were entirely absent. The average ratio of females to males in the material examined approximated 14 to one, while in several instances this ratio dropped to eight to one.

Syphacia peromysci Harkema, 1936

From the caeca of eight white-footed mice Peromyscus maniculatus Baird, 144 specimens of Syphacia peromysci Harkema, 1936 were recovered in the vicinity of Manhattan, Kansas.

Description: Male 0.974 to 1.32 mm long and 0.093 to 0.134 mm wide. The esophagus is typically oxyuroid, 0.125 to 0.148 mm long and 0.029 mm wide at the widest part. The esophageal bulb is spherical 0.048 to 0.059 mm in diameter and is joined to the esophagus by a slender constriction. The nerve ring surrounds the esophagus approximately 0.095 mm from the anterior end. The cervical papillae are prominent

and are situated 0.106 mm from the anterior end of the worm. There are two small symmetrical bursal alae and three pairs of caudal papillae. The spicule is 0.069 to 0.073 mm long and 0.004 mm wide at its widest part. The gubernaculum is 0.037 to 0.038 mm long by 0.005 mm wide, and the accessory piece is 0.017 to 0.021 mm long. The ventral surface of the body bears three striated mamelons, the largest of which averages 0.068 mm in length and extends beyond the cuticule 0.023 mm.

Female 2.0 to 4.2 mm in length and 0.173 to 0.177 mm wide. The esophagus including the bulb is 0.347 to 0.348 mm long by 0.048 mm wide at the widest part. The esophageal bulb is 0.078 to 0.085 mm in diameter. The nerve ring is 0.084 mm from the anterior end of the worm. The anus is situated 0.649 mm from the tip of the tail. The vulva is located on a cuticular prominence, 0.707 to 0.736 mm from the anterior end. The eggs are oval 0.080 to 0.087 mm long by 0.023 mm wide.

Host: Peromyscus maniculatus bairdii Hoy and Kennicot

Habitat: Caecum

Locality: Manhattan, Kansas

Discussion: Harkema (1936) stated that Syphacia peromysci resembles Syphacia obvelata Rudolphi, 1802, the type species of the genus, in body form and the number of mamelons in the male, and differs in that the former species is smaller than the latter in many respects. The most

outstanding variations reported are the greater distance the mamelons extend beyond the cuticle, and the smaller size of the eggs in S. peromysci. While the material examined in this survey resembles closely that of Harkema, several variations were evident. The length of the adult female is reported by Harkema to be 2 to 2.5 mm. The writer, however, observed specimens which attained a length of 4.2 mm, or within the range of the measurements reported for females of S. obvelata. In addition the vulva of S. peromysci is reported as measuring 0.507 to 0.534 mm from the anterior end while this same measurement was found to be 0.707 to 0.736 mm in the present material, which corresponds more nearly to that reported for S. obvelata. Finally, several male specimens were observed whose mamelons did not extend beyond the cuticle as distinctly as did those reported by Harkema, but which protruded only a short distance beyond the body cuticle. These same worms were found to correspond in other respects to S. peromysci.

While these variations might appear inconsequential in relation to the over all description, they do, nevertheless bring the two species, S. obvelata and S. peromysci, more closely together in general morphology. Indications are that extreme caution must be exercised in the reporting of these species. Additional and more inclusive studies may, in the future, result in the reduction of S. peromysci to a synonym of S. obvelata.

Dermatoxys veligera Rudolphi, 1819

Eleven specimens of the nematode species Dermatoxys veligera Rudolphi, 1819 were recovered from the caeca of three cottontail rabbits, Sylvilagus floridanus mearnsi Allen, at Manhattan, Kansas.

Description: Two cervical alae extend from the head to a point posterior to the esophageal bulb; transverse striations 0.005 mm in width. The esophagus terminates posteriorly in a bulb, the union being marked only by the external widening and by some rugose markings. Mouth with three lips, each bearing two papillae. Vestibule short and provided with three teeth. The ovaries are massive and deeply colored.

Female length 16 mm, with a maximum thickness of 0.583 mm. The posterior extremity is conical and regularly attenuated. The tail is 2.0 mm long or one-eighth of the length of the body. The vulva is situated in the anterior half of the nematode 6.34 mm from the anterior end, and is approximately 0.070 mm broad. It opens into a vagina lined with a thick cuticle and joining a cuticular ovijector which extends anteriorly for a distance of 0.887 mm. In its distal region corresponding to a sphincter, there is a deeply colored glandular organ, which in turn connects with the anterior musculo-epithelial portion of the ovijector. The uteri extend to beyond the anus and this region is crowded with eggs which fill the twin uteri anteriorly to the vulva. The eggs measure 0.107 mm long by 0.058 mm in diameter, have

a thick shell and show an interruption at the one end for the exit of the embryo. No males were recovered.

Host: Sylvilagus floridanus mearnsi (Allen)

Habitat: Caecum

Locality: Manhattan, Kansas

Aspicularis tetraptera Nitzsch, 1821

Of 13 house mice Mus musculus Linnaeus, examined from the vicinity of Manhattan, Kansas, two were found infected with the oxyurid Aspicularis tetraptera Nitzsch, 1821.

Description: Male length 3.42 mm; maximum width 0.171 mm. The posterior extremity is not coiled in a tight spiral. The esophagus exclusive of the bulb is 0.245 mm long and 0.036 mm wide. The subglobular esophageal bulb is 0.111 mm long by 0.063 mm wide. Two prominent fan-shaped cervical alae are present measuring 0.083 mm in length and 0.030 mm in width. The head including the inflated cuticle is 0.090 mm in diameter. The nerve ring is approximately 0.139 mm from the anterior end. The anus is 0.140 mm from the tip of the tail. One pair of pre-anal papillae and several pairs of post-anal papillae are present. The caudal alae are located on the outside curve of the tail and at its distal extremity. They measure 0.053 mm by 0.014 mm. The spicule is either reduced or imperfectly chitinized and is not visible with ordinary technique.

Female length 3.72 mm; maximum width 0.215 mm. The

esophagus, exclusive of the bulb is 0.275 mm long by 0.041 mm wide. The subglobular esophageal bulb is 0.129 mm long by 0.075 mm wide. It contains a valvular apparatus and is separated from the rest of the esophagus by a constriction. The nerve ring is located approximately 0.147 mm from the anterior end. Cervical alae present measuring 0.360 mm from the anterior end of the specimen and 0.024 mm wide terminating abruptly behind the level of the subesophageal bulb. Vulva 1.48 mm from the anterior end. The tail is short, blunt and conical and the anus measures 0.405 mm from the distal end of the tail. The vulva leads into a muscular ovijector which in turn leads into a long tortuous vagina most of which is located anterior to the vulva. The excretory pore is approximately 0.600 mm from the anterior end. The eggs are embryonated when laid and measure 0.090 mm by 0.045 mm.

Host: Mus musculus musculus Linnaeus

Habitat: Caecum

Locality: Manhattan, Kansas

Discussion: It was significant to note that the length of the male specimens collected in this survey had a maximum length of 3.42 mm while those previously reported, Hall, 1916, Schulz, 1924, attained a maximum length of 2.6 mm. This, however, was the only variation of any consequence observed, and was not thought adequate to warrant separation from A. tetraptera.

Since the material studied was recovered from the house

mouse in a mixed infection with Syphacia obvelata, it was felt that occurrence of A. tetraptera may be more prevalent than is suspected, as the similar morphology and predominance of S. obvelata in these infections renders recognition of A. tetraptera difficult unless the examiner scrutinizes closely each roundworm found. A further indication which seemingly substantiates this assumption is the almost total absence in recent literature of any data concerning this nematode as having been recovered from rodents.

Family Trichuridae Railliet, 1915

Medium to large worms; the anterior (esophageal) part of the body may be longer or shorter than the posterior; posterior part of the body may be much thicker than the anterior or only slightly thicker; mouth simple, lips inconspicuous or absent. Male: spicule single, or rarely with copulatory sheath. Female: vulva near termination of esophagus, oviparous, eggs with a thick shell, barrel-shaped, with plugs at each end and containing when deposited an unsegmented ovum.

Trichuris sylvilagi Tiner, 1950

Three specimens of the whipworm Trichuris sylvilagi Tiner, 1950 were recovered at Manhattan, Kansas from the caecum of the cottontail rabbit Sylvilagus floridanus mearnsi Allen.

Description: Male length approximately 25 to 30 mm (esophageal region incomplete); thick portion of body 13.7 mm. The width of the esophagus is 0.122 mm; width at junction of esophagus and intestine is 0.225 mm; of rear portion of body at the point of the spicule sheath is 0.099 mm. The diameter of the thick portion of the body measures 0.510 mm. The spicule measures approximately 6.7 mm in length. The spicule sheath is without spines and rather narrow. The cloacal tube is narrow, and about one-third of the length of the thick part of the body. Spicular sheath present, ending well in front of the origin of the cloaca. Ejaculatory duct long, approximately 6.47 mm, or nearly half the length of the thick part of the body and about twice as long as the vas deferens which measures 3.06 mm. The testes are convoluted in such a way as to give the appearance of a series of squarish compartments, ending near the middle of the length of the cloacal tube.

Female length approximately 22 to 28 mm (esophageal region incomplete); thick portion of body 7.88 mm long. The width of the esophagus at its junction with the intestine is 0.265 mm. The vulva is located at the junction of the esophagus and intestine and is circular in outline and without marked prominences. The ovijector is much convoluted. The eggs possess opercular plugs and measure 0.052 mm long by 0.029 mm thick.

Host: Sylvilagus floridanus mearnsi Allen

Habitat: Caecum

Locality: Manhattan, Kansas

Discussion: Tiner (1950), after having examined a collection of whipworms, was convinced that the species Trichuris leporis Hall, 1916, included two species distinguishable by the variation in spicule length. The male of one of the included species has a relatively short spicule (about 1.6 to 3.2 mm), and Tiner restricted T. leporis to this form. The male of the second species which had been included with T. leporis has a relatively long spicule (6 to 8 mm), and has been described by Chandler (1930). It is apparently host specific for the cottontail rabbit and the name T. sylvilagi was proposed for it by Tiner (1950).

On the basis of the relative spicule lengths of these two species, as proposed by Tiner, the specimens recovered in this survey unquestionably fall into the group reported by Chandler which Tiner designated as T. sylvilagi.

Trichuris sp. Roederer, 1761

From the caecum of the prairie meadow vole Microtus ochrogaster ochrogaster (Wagner), one specimen of whipworm was recovered near Manhattan, Kansas.

Description: Female length 27.1 mm; esophageal region 16.3 mm long; thick portion of body 10.8 mm. Width of head

0.021 mm; of mid-esophageal region 0.136 mm; at junction of esophagus and intestine 0.141 mm. The maximum width at the posterior portion of the body is 0.333 mm. The vulva at the junction of the esophagus and intestine causes a slight swelling which narrows posteriorly for a short distance before widening into the body. Ovijector not convoluted. Eggs with opercular plugs and measuring 0.056 mm by 0.031 mm including plugs. The ovary is 0.326 mm from the posterior end and is attached posteriorly by a ligament. Anus subterminal.

Host: Microtus ochrogaster ochrogaster (Wagner)

Habitat: Caecum

Locality: Manhattan, Kansas

Discussion: Because of the absence of male specimens of this species, with which identifications are most frequently made, it was thought advisable to record the above described specimen as Trichuris sp.

Family Thelaziidae Railliet, 1916

Lips inconspicuous; buccal cavity well developed; posterior end of male usually spirally coiled and bearing lateral alae and papillae; spicules unequal and dissimilar; eggs thick-shelled, containing larva when laid. Adults in vertebrates.

Rictularia coloradensis Hall, 1916
Plate I

Of 143 white-footed mice, Peromyscus spp. collected near Manhattan, Kansas, eight harbored the nematode species Rictularia coloradensis Hall, 1916.

Description: Male length 1.95 mm; maximum diameter 0.135 mm. Two rows of 42 ventral cuticular spines are present, extending to within 0.370 mm of the tip of the tail. Maximum length of spines 0.045 mm. The buccal capsule is well sclerotized, 0.021 mm deep and 0.014 mm in diameter at the base. The anterior portion of the buccal cavity is bordered with about 12 denticles. The nerve ring is 0.105 mm from the anterior end and the cervical papillae are 0.186 to 0.243 mm from this same end. The esophagus measures 0.577 mm in length. The cloaca is about 0.078 mm from the tip of the tail. The spicules are two in number, curved and unequal, 0.063 mm and 0.096 mm, respectively. The area around the cloaca appears to be chitinized. Two fan-shaped mamelons are located anterior to the cloaca; the posterior mamelon measures 0.041 mm long by 0.017 mm wide, while the anterior mamelon measures 0.038 mm long by 0.014 mm wide.

Female: length 20.6 to 28.4 mm; maximum diameter 0.442 to 0.680 mm. Buccal cavity measures 0.065 to 0.071 mm deep and 0.071 to 0.078 mm wide at the base. The cervical papillae are located at sub-equal levels 0.400 mm from the anterior end. The esophagus is 2.42 to 3.88 mm from the anterior end.

Vulva 2.23 to 3.58 mm from the anterior end and 0.029 to 0.065 mm in front of the end of the esophagus. The total number of pairs of spines is 59 to 67, including 31 to 33 pairs of combs (those anterior to the vulva), and 33 to 37 pairs of spines (those posterior to the vulva). The combs reach a maximum length of 0.095 to 0.096 mm. The posterior one-third to one-ninth of the body surface is free of spines. The tail is 0.265 to 0.500 mm long. The eggs measure 0.045 to 0.047 mm in length and 0.033 to 0.036 mm in diameter.

Hosts: Peromyscus maniculatus bairdii (Hoy and Kennicott)
P. leucopus noveboracensis (Fisher)

Habitat: Duodenum

Locality: Manhattan, Kansas

Discussion: Rictularia coloradensis was originally described by Hall (1916), the identification being made with an incomplete female which Hall assumed to be 9 to 10 mm in length. In 1939, Cuckler referred to Hall's description and used his data on R. coloradensis as criteria in the formulation of a key to the species of Rictularia. Chandler (1941) also employed Hall's description as an aid in distinguishing a new species, R. ondatrae Chandler (1941) from the muskrat. Tiner (1948) redescribed R. coloradensis giving the length of the female as 15.8 to 29.4 mm. The males described by Tiner did not fit the description given by Hall (1916) since they possessed three pre-cloacal fans and spicules that were unequal and less than half as long.

The writer after having made comparisons found the female Rictularia specimens in his material to resemble most closely those of Tiner. The males, however, fitted neither Tiner's nor Hall's data, and showed several variations, among them a shorter esophagus, two instead of three cuticular mamelons, a smaller buccal cavity, and shorter spines. Several other minor variations were also in evidence. Tiner stated, "the differences of the males may be sufficient to constitute a new species", but went on to say, "this cannot be decided until more male specimens have been studied, particularly from the western states."

Since this material was limited to only 11 specimens, 10 females and one male, it was thought wise to follow Tiner's lead and consider this material co-specific with R. coloradensis on the basis of the female characteristics which closely resembled those reported by Tiner.

Family Spiruridea Oerley, 1885

Mouth usually with trilobed lateral lips, or definite lips absent; esophagus long and cylindrical, and divided into a short anterior muscular portion, and a longer glandular part; cervical papillae, usually at least one in front of the nerve ring; caudal alae on male well developed and supported by pedunculated papillae; eggs oviparous; parasites of esophagus, stomach and intestines of vertebrates.

Gongylonema sp. Molin, 1857
Plate II

Fifteen specimens of the nematode genus Gongylonema Molin, 1857 were recovered from the stomach wall of two prairie meadow voles and one white-footed mouse, in the vicinity of Manhattan, Kansas.

Description: The body is filiform and slightly attenuated toward the two extremities. The cuticle is transversely striated. The anterior portion of the body is provided with longitudinal rows of cuticular plaques. The esophagus consists of two distinct portions, a slender anterior portion and a thicker posterior portion. The tail of the male is curved ventrally and is provided with two asymmetrical alae supported by elongate pedunculate papillae. The eggs are oval and contain well developed embryos when oviposited.

The male measures 12.8 to 22 mm long and 0.141 to 0.158 mm wide. The cuticle is 0.006 mm thick. The esophagus is 2.85 to 3.42 mm in length. The tail is twisted slightly on its long axis. The longest caudal ala is approximately 1.10 mm long and 0.211 mm wide. The alae are asymmetrical, one side being a third shorter than the other. The alae possess constrictions at their midpoints, the longer side being more pronounced and slightly posterior to the shorter side. There are 10 to 12 pairs of papillae which are long and pedunculate. The papillae are asymmetrically arranged, five to six pairs being located preanally and the

same number posteriorly. The longest papillae measure 0.032 mm, while the shortest measure 0.014 mm. The spicules are dissimilar. The short one is sword-shaped and appears to be bifurcated along its length giving the appearance of two spicules. It measures 0.081 to 0.114 mm long by 0.032 mm thick at its widest point. The long spicule is of uniform thickness except for a slight dilation toward the proximal end. It measures 0.900 to 1.61 mm in length and attains a maximum thickness of 0.014 mm at its proximal end. The long spicule may or may not be protruded, but when so the protruded portion is bent at a right angle to the proximal portion of the anal opening. The gubernaculum lies below the spicules near the distal end of the smaller spicule and measures 0.071 to 0.090 mm in length and 0.014 mm in thickness.

The female measures 51 to 136 mm by 0.326 to 0.379 mm. The cuticle is 0.034 mm thick. The buccal capsule is inconspicuous as are the lips. The nerve ring is 0.109 mm from the anterior tip of the body while the cervical papillae are 0.095 to 0.106 mm from the same end. The esophagus measures 6.6 to 9.31 mm or roughly one-fifteenth of the length of the entire worm. A vulva was observed in only one of four specimens and measured 5.44 mm from the posterior end of the nematode. The eggs measure 0.060 mm long by 0.036 mm in diameter and contain a well developed embryo at the time of oviposition.

Hosts: Microtus ochrogaster ochrogaster Wagner

Peromyscus maniculatus bairdii Hoy and Kennicott

Habitat: Stomach wall

Locality: Manhattan, Kansas

Discussion: A tentative survey of the available literature has revealed no data concerning the recovery of Gongylonema from either of the host animals listed above. According to Yorke and Maplestone, 1926 several species of Gongylonema have been reported from rodents, among them, G. musculi (Rudolphi, 1819) Neumann, 1894; G. neoplasticum Fibiger and Ditlevsen, 1914; G. problematicum Schulz, 1924; G. brevispiculum Seurat, 1914 and G. orientale Yokogawa, 1925, none of which was reported from the prairie meadow vole or the white-footed mouse. Upon making a comparison of most of these species with the material examined in this survey (Table 4) the variations were found to be too extensive to warrant any specific identification on the basis of any available literature. Most conspicuous of the variations observed were the noticeably longer lengths of the esophagus, caudal alae and particularly the long spicule which was almost twice as long as any previously reported from rodents. It was thought that due to the circumstances stated above, this material most probably represents a new species, but it is reported as Gongylonema sp. until further investigation into the literature has been made.

Family Heterakidae Railliet and Henry, 1914

Medium-sized or small worms with three lips and a small buccal capsule or pharynx; esophagus usually provided with a posterior bulb; male provided with a circular or groove-like sucker anterior to the cloacal opening; female with vulva situated near the middle of the body.

Heterakis spumosa Schneider, 1866

Six roundworms of the species Heterakis spumosa were recovered from the large intestines of a Norway rat at Manhattan, Kansas.

Description: The head is 0.075 mm in diameter. The mouth possesses three distinct subequal lips, with one median papillae on each lip. The small mouth cavity is followed immediately by the esophagus which, exclusive of the bulb, measures 0.632 mm long and 0.056 mm in diameter. The bulb is 0.300 mm long and 0.161 mm in diameter. The cavity of the bulb is dilated posteriorly and lined with a chitinous investment. The cuticle shows fine longitudinal and transverse striations. The excretory pore is 0.490 mm from the anterior end.

The male measures 7.2 mm long with a maximum thickness of 0.306 mm. There is a well developed bursa which originates anterior to the preanal sucker. It is sustained in the anal region by three pairs of papillae and is notched at the distal termination of the third of these. The posterior portion

Table 4. Comparative analysis of some *Gongylonema* spp. reported from rodents.

Description	<i>G. musculi</i> (Rudolphi, 1819) Neumann, 1894		<i>G. brevispiculum</i> Seurat, 1914		<i>G. neoplasticum</i> (Fiber & Ditlevsen, 1914) Ransom & Hall, 1916		<i>G. orientale</i> Yokogawa, 1925		<i>Gongylonema</i> (this paper)	
	male	female	male	female	male	female	male	female	male	female
Total length	8.8 mm	17.5-21.6 mm	17 mm	70 mm	15-20 mm	60-80 mm	9-16 mm	45-115 mm	12.8-22 mm	51-136 mm
Maximum width	_____	0.154	0.190	0.336	0.110-0.130	0.170-0.326	0.095-0.15	0.26-0.35	0.141-0.158	0.326-0.379
Length of entire esophagus	_____	_____	1/4 body length	1/9 body length	1/4 body length	1/9 body length	1/3 to 1/6 body length	1/8 to 1/13 body length	1/7 body length	1/15 body length
Length of caudal alae (long side)	_____	_____	0.480	_____	0.462	_____	0.42 -0.53	_____	1.10	_____
Caudal papillae										
Number of pairs	14	_____	12	_____	8	_____	_____	_____	10-12	_____
Arrangement	_____	_____	_____	_____	Asymmetrical	_____	_____	_____	Asymmetrical	_____
Long spicule) Length	_____	_____	0.660	_____	0.528	_____	0.622	_____	0.900-1.61	_____
Short) Length	_____	_____	0.085	_____	0.093	_____	0.073-0.094	_____	0.081-0.114	_____
spicule) Width	_____	_____	0.018	_____	_____	_____	0.009-0.016	_____	0.032	_____
Vulva position	_____	_____	_____	8 mm ant. to anus	_____	1/8 to 1/10 body length	_____	near post. end	_____	5.44 mm from post.
Egg) Length	_____	0.045	_____	0.042	_____	0.060	_____	0.057	_____	0.053-0.060
Egg) Width	_____	0.023	_____	0.025	_____	0.040	_____	0.034	_____	0.033-0.037

Measurements for the species *G. musculi*, *G. brevispiculum* and *G. neoplasticum* obtained from Hall, 1916.

distal to the bursal notch is supported by three pairs of papillae and extends to the tip of the acutely pointed tail. Of the three pairs of papillae sustaining the bursa of the anal region the anterior pair is the largest. The proximal portion appears thick and granular, the diminished distal portion is thin and clear. The next pair of papillae behind this is shorter and has the same general structure. The third pair, that in relation to the bursal notch, does not show this same structure; it is longer and thinner than the preceding pairs. Of the three pairs of papillae supporting the bursa along the tail proper the anterior pair is the thinnest, the middle the thickest and the posterior pair intermediate in thickness. These are all approximately the same length. In addition to the six pairs of papillae, there are four other pairs. Of these two stalked pairs are located in the region of the sucker. The two remaining pair are sessile and are in the vicinity of the cloacal aperture. The sucker is a powerful pedunculate structure, with a strong chitinous investment interrupted on the posterior border by a papilli-form elevation. The sucker is elliptical with a transverse diameter of 0.090 mm and a longitudinal diameter of 0.060 mm. There are well developed muscular strands from the base of the sucker to the opposite body wall. The spicules are subequal, 0.311 mm in length and have a pronounced longitudinal striation. They are thickest at the proximal end, 0.017 mm in diameter, and taper gradually to a point. They are curved

at the distal end. The proximal end in a short open hook bending laterally. The distance from the posterior margin of the sucker to the tip of the tail is 0.510 mm; the distance from the cloacal aperture to the tip of the tail is 0.315 mm.

The female length is 10.4 mm with a diameter of 0.388 mm. The anus is 0.850 mm from the posterior end of the body. The vulva is slightly posterior to the middle of the body 5.44 mm from the anterior end. It has two prominent transverse lips with one, two or three cuticular prominences before and behind it in the midventral line. The vagina appears to be surrounded by a spiral band for some distance back from the region near the vulva. Each lip of the vulva bears two small papillae. From the vulva the vagina turns forward for a short distance and then turns and extends posteriorly for a short distance at which point it forks to form the anterior and posterior uterine branches. These extend forward and backwards, respectively, and then turn back, transform into the ovaries, and as such make their way in numerous transverse loops through the anterior and posterior ends of the body. The egg has a mamillated shell and is 0.059 mm by 0.045 mm in diameter.

Host: Rattus norvegicus Erxleben

Habitat: Large Intestine

Locality: Manhattan, Kansas

CLASS TREMATODA

Family Dicrocoeliidae Odhner, 1910

Elongate, flattened distomes of small or medium size with suckers not far apart in the anterior region of body; cirrus and cirrus pouch small, mainly in front of the ventral sucker, and opening in the median plane; testes close behind the ventral sucker, their relative positions variable; ovary behind the testes; vitellaria fairly well developed, lateral to caeca in the middle region of body; uterus having both ascending and descending limbs abundantly folded, the folds filling most of the body behind the gonads.

Eurytrema sp. Looss, 1907

Five specimens of trematodes of the genus Eurytrema Looss, 1907 were recovered from the liver of a house mouse near Manhattan, Kansas.

Description: The body is oblong, 6.56 mm in length by 1.38 mm in width at the ovarian level. The cuticula is without spines. The oral sucker is subterminal, 0.442 mm in diameter, while the acetabulum is pre-equatorial and measures 0.489 mm in diameter. The pharynx is 0.224 mm in diameter. The esophagus is longer than the pharynx. Intestinal caecae extend posteriorly beyond the lower level of the vitellaria and terminate near the posterior end of the body. The testes are spherical to subspherical, 0.299

mm in diameter and widely separated, located one on either posterior lateral edge of the acetabulum. The cirrus sac is 0.408 mm long by 0.136 mm wide, and is located midway between the pharynx and the acetabulum. The genital pore is median, at the basal level of the pharynx. The ovary is subspherical, 0.340 mm in diameter, pre-equatorial and slightly lateral to the median line of the body. The seminal receptacle measures 0.136 mm in diameter and is situated posterior to the ovary. The Laurer's canal was not observed. The vitelline reservoir and Mehlis gland are median, pre-equatorial and posterior to the ovary. Vitellaria are extracecal, extending from within the zone of the acetabulum and terminating in the anterior portion of the posterior third of the body. The uterus extends from the acetabular region to the posterior end of the body and almost fills this entire area. Eggs are oval 0.032 mm by 0.018 mm in size.

Host: Mus musculus musculus Linnaeus

Habitat: Liver

Locality: Manhattan, Kansas

Discussion: The recovery of flukes from rodents, other than from muskrats and beavers, is relatively infrequent due primarily to their terrestrial existence. In most instances the molluscan host of rodent trematodes has proved to be a land snail. Several species have been reported nevertheless. McIntose (1939) on the basis of five specimens, described a

dicrocoeliid trematode Eurytrema komareki McIntosh from the white footed mouse. Examination of the specimens recovered in this survey revealed that they resembled E. komareki closely in general morphology. Structural measurements, however, were found to be on an average, twice as large in the writer's material as those given by McIntosh (Table 5). Since the lack of sufficient material prevented positive identification as to species the material is, therefore, reported as Eurytrema sp.

Family Brachylaemidae Joyeux and Foley, 1930

More or less elongate distomes with usually a smooth body, intestinal caeca extending to posterior end of body; testes posterior in position, tandem or slightly diagonal; ovary lying between testes; vitellaria follicular and occupying lateral fields; cirrus sac containing cirrus, but seminal vesicles lying free; parasites of intestines of vertebrates.

Itygonimus sp.(?) Luhe, 1899

Thirty-three specimens of trematodes were removed from the small intestines of six short-tailed shrews Blarina brevicauda brevicauda Say, near Manhattan, Kansas. This material was easily placed in the family Brachylaemidae, but no positive generic diagnosis was obtained. A review of the literature failed to reveal any pertinent data on these trematodes. However, by the use of descriptive keys formulated

Table 5. A comparison of Eurytrema komareki McIntosh, 1939 with Eurytrema sp. (this paper).

Description	: <u>E. komareki</u> McIntosh, 1939	: <u>Eurytrema</u> sp. (this paper)	: Ratio in size
Body length	2.82 mm	6.56	2.3
Body width	0.800	1.38	1.7
Oral sucker	0.200	0.442	2.2
Acetabulum	0.320	0.489	1.5
Pharynx	0.100	0.224	2.2
Esophagus	Longer than pharynx	Longer than pharynx	—
)Shape	Subspherical to elongate	Spherical to subspherical	—
Testes)Size	0.090 to 0.200	0.299	1.9
)Position	Posterior lateral edge of acetabulum	Posterior lateral edge of acetabulum	—
Cirrus	0.140 by 0.050	0.408 by 0.136	2.1 by 2.6
Genital pore	Median at basal level of pharynx	Median at basal level of pharynx	—
Ovary	0.130 to 0.140	0.340	2.2
Seminal receptacle	0.070 to 0.085	0.136	1.8
Uterus	Confined to intercecal area	May extend laterally beyond ceca	—
Eggs	0.030 by 0.023	0.032 by 0.018	Not significant

by Dawes (1946), these specimens were found to exhibit the morphological characteristics of the genus Itygonimus Lühe, 1899 which has been reported as occurring in moles. Since the features of these trematodes resembled in general appearance those of the genus Itygonimus, and, since of the four genera listed from the family Brachylaemidae, only this genus has been recorded from Insectivores, it is assumed that this material belongs in the genus Itygonimus.

ECOLOGY

While taxonomic studies concerning the helminths parasitic in small mammals, especially mouse-like rodents, have been made in recent years, very little data has been forthcoming relative to the ecological relationships which undoubtedly influence, to a great degree, the incidence of parasitism in these animals. According to Kuns and Rausch (1950), Elton et al. in 1931 studied the helminths of Apodemus sylvaticus Linnaeus and reported a correlation of parasitism and age. Rodent parasites were studied in North Carolina by Harkema (1936), with reference to seasonal fluctuations. An intensive study on the ecology of certain mouse-like rodents in the Transcaucasus region of Russia was carried on by Kirschenblatt in 1938 according to Kuns and Rausch (1950). Rankin (1945) studied the helminth parasites of various rodents in the state of Washington. To date the most complete studies of the ecology of helminths

parasitic in voles is that of Rausch and Tiner (1949 and 1950) in which various species of parasites were considered.

The mammals examined in the present survey while representing a cross-section of the mouse-like rodent species to be found in this area, were obtained under circumstances which rendered an ecological study difficult to conduct. In the first place animal trapping was usually accomplished in a random fashion, the idea being primarily to secure animals for helminth examination. Little attention was given to the method of trapping and to the habitats trapped. Consequently, such ecological aspects as population data, seasonal fluctuations and plant varieties can not be analysed in relation to parasitic incidence with any degree of accuracy. Secondly, since the topography of the country in the trapping area consisted of relatively flat bottom lands bordered by low limestone and flint hills, the altitude variations were not significant to cause any severe change of vegetative habitats as might be found in mountainous areas where constantly changing altitudes result in the formation of vegetative habitats almost completely dissimilar, and mechanical barriers which separate the various faunal species into more or less definite areas. Lastly, because of the agricultural practices of this part of Kansas, that of raising beef cattle, the greater majority of the terrain is utilized as grazing land, therefore, the vegetation in this area is, for all practical purposes, exceedingly similar, the

only variation being exhibited in the various stages of succession which are exhibited. Wooded areas are small and usually limited to draws located between hills, and are consequently of little value from an ecological point of view.

From the standpoint of plant varieties, approximately 80 per cent of the areas trapped can be considered as being practically identical. A few plant species predominated but several secondary and tertiary species were present. The habitats may be separated into three areas.

(a) Grazing areas: Big and little blue stem grass predominated but there were secondary invaders such as Kentucky blue grass, dropseed, buffalo bur, Indian grass and pitcher sage. Eighty-two per cent of the animals in this study were collected in grazing areas.

The most abundant animal species obtained from this habitat was the prairie meadow vole. Approximately 57 per cent of these rodents were found infected with eight species of helminths, many of which occurred in mixed infections. Since voles feed essentially on grasses, and to a lesser degree on grain, tree bark and other vegetable matter, it might appear that the high incidence of infection could be attributed to the food habits of these animals, because the same helminth species were recovered from voles resident in other habitats. The second most abundant rodent recovered was the white-footed mouse, of which only 17 per cent were found parasitized. These were infected with only four species

of helminths which were usually restricted to animals in certain specific areas. In some areas the mice were found to be entirely free of parasites.

The short-tailed shrew proved to be a frequent inhabitant of the blue stem areas and usually a fair host animal. Only 11 per cent were found infected with two species of adult helminths, although several immature species were recovered but not identified. The other animal species examined from grazing areas were in lesser abundance, only a few of which were found parasitized.

(b) Cultivated areas: These areas consisted of Brome alfalfa pasture, sorgum, and cut grain fields. Eleven per cent of the animals were collected in this type of habitat.

The white-footed mouse was found most abundant in these areas but yielded few helminths. In secondary abundance was the house mouse in which four species of helminths were recovered constituting a 46 per cent infection. Other rodents trapped in cultivated areas were the harvest mouse, Reithodontomys spp., and the cotton rat, none of which was found parasitized.

(c) Uncultivated lands not used for grazing. The vegetation was heterogeneous and included combinations of such plant species as foxtail, smartweed, Russian thistle, annual sunflower, giant ragweed, milkweed, night shade, goldenrod, blue stem, ironweed, muhley grass, snow on the mountain, sensitive rose, blue grass, purple love grass,

ladies thumb and cord grass. Seven per cent of the animals were collected in this type of habitat.

Prominent host species trapped in this habitat were the cotton rat and short-tailed shrew. Other animals recovered in less abundance were the prairie meadow vole, white-footed mouse and the house mouse. These animals were found to be only moderately parasitized and the helminth species recovered were identical with material recovered from similar animals from the other habitats.

Cottontail rabbits and fox squirrels were obtained in blue stem grazing areas and wooded areas respectively, while the Norway rats were trapped at the Manhattan City Dump. The recovery from these rats of Cysticercus fasciolaris the larval stage of Taenia taeniaformis is to be expected in a situation where numerous cats which serve as definitive hosts frequent the area.

It was noted that the greater number and variety of helminths were recovered from rodents in the blue stem grazing areas where these animals were found in abundance. The vegetation in these areas was, in most cases, in middle to late succession and aside from grazing was practically unmolested by man. The incidence of infection was highest in the spring, summer and fall, or throughout the warm seasons of the year and fell off noticeably during mid-winter. The significance, if any, of these factors is difficult to determine as the number of hosts so far examined from these areas is

hardly large enough to allow any conclusions concerning helminth abundance and distribution in relation to the physical, edaphic and biotic factors exhibited in the trapping areas.

SUMMARY

1. A total of 356 small mammals consisting of 10 genera and 12 species of the order Rodentia, one species of Insectivora and one species of Lagomorpha were captured in Kansas and examined for helminth parasites.

2. From these animals 13 species of cestodes, nine species of nematodes and two species of trematodes were recovered and identified.

3. Of the cestodes, six species were identified from the family Anoplocephalidae Fuhrmann, 1907; three species from the family Hymenolepididae Fuhrmann, 1907; two species from the family Dilepididae Fuhrmann, 1907; and two species from the family Taeniidae Ludwig, 1886. The nematodes identified constituted four species from the family Oxyuridae Cobbold, 1864; two species from the family Trichuridae Railliet, 1915; one species from the family Thelaziidae Railliet, 1916; one species from the family Spiruridea Oerley, 1885; and one species from the family Heterakidae Railliet and Henry, 1914. Two species of trematodes were recovered and tentatively identified to genus from the families Dicrocoeliidae Odhner, 1910, and Brachylaemidae

Joyeux and Foley, 1930.

4. A question was raised as to the validity of separating the species Syphacia obvelata and S. peromysci on the basis of the distance the male mamelons extend beyond the cuticle ventrally, and the smaller egg size in S. peromysci. The material examined in this survey seemed to exhibit a stage somewhat intermediate between these two species.

5. Examination of a male specimen of the nematode, Rictularia coloradensis, showed many morphological variations from the original description, indicating the possibility of emending this genus after examination of a large series of specimens.

6. Specimens of the nematode genus Gongylonema were recovered from two species of host animals, and are thought to constitute a new species.

7. Ecologically the trapping areas were divided into grazing areas, cultivated areas and uncultivated areas not used for grazing. Eighty-two per cent of the animals trapped were obtained from grazing areas in which helminth incidence proved greater than from the other areas. The incidence of helminth infection was found heaviest in the prairie meadow vole, cottontail rabbit and house mouse, while other species were only moderately to poorly infected. Six species of mammals were found entirely devoid of helminth parasites.

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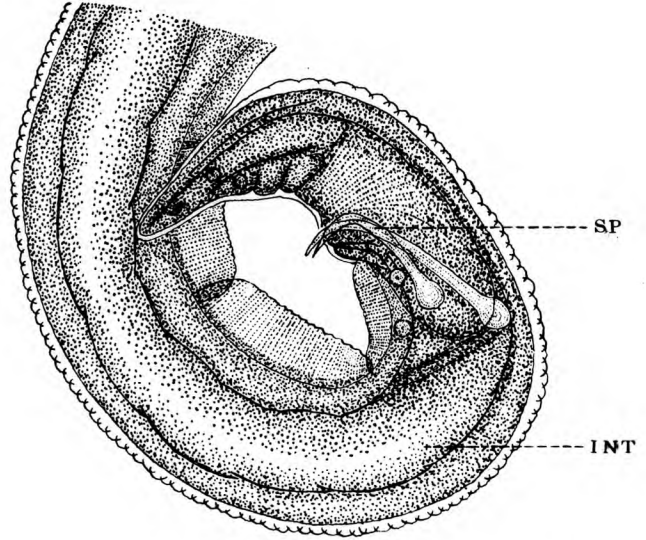
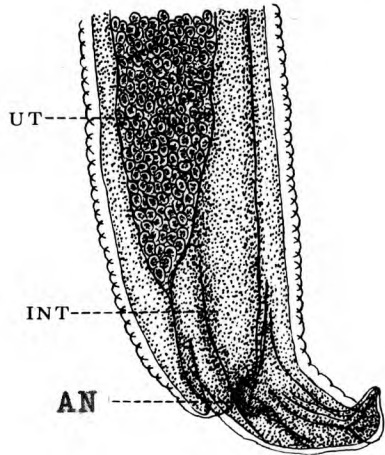
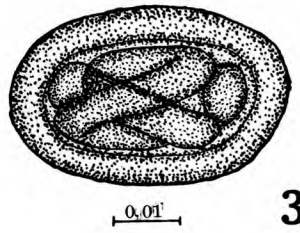
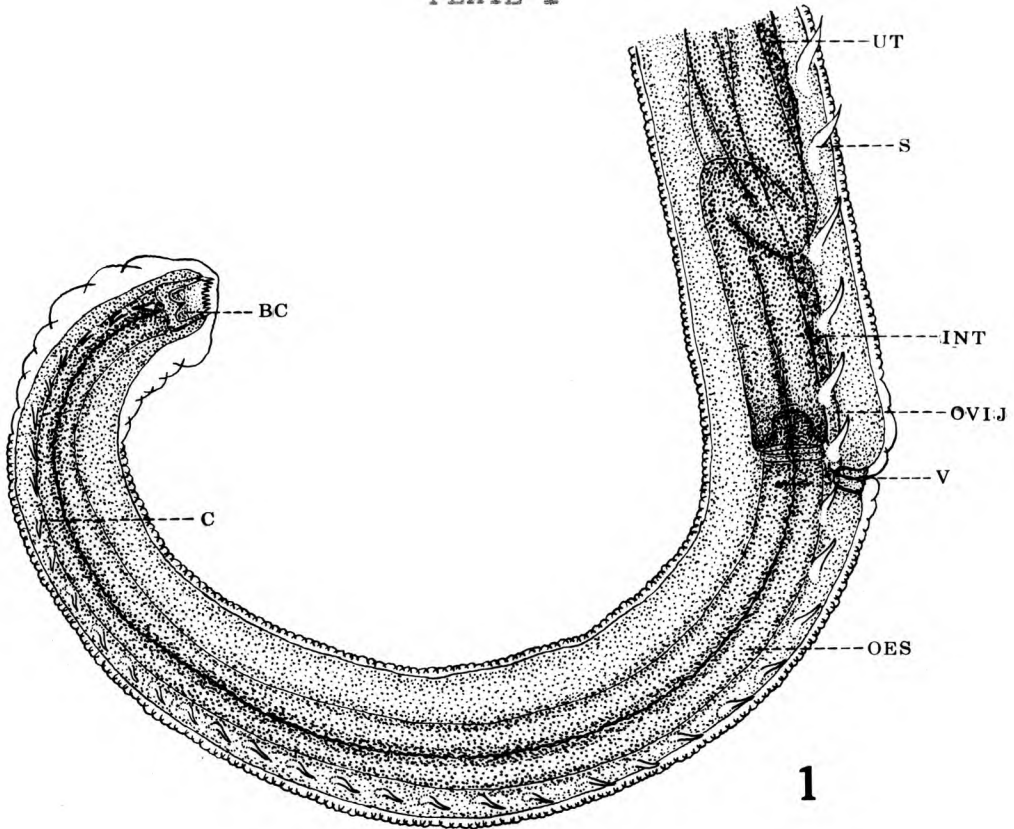
APPENDIX

EXPLANATION OF PLATE I

Rictularia coloradensis

- Fig. 1. Anterior end of female
- Fig. 2. Posterior end of female
- Fig. 3. Embryonated egg
- Fig. 4. Posterior end of male

PLATE I



EXPLANATION OF PLATE II

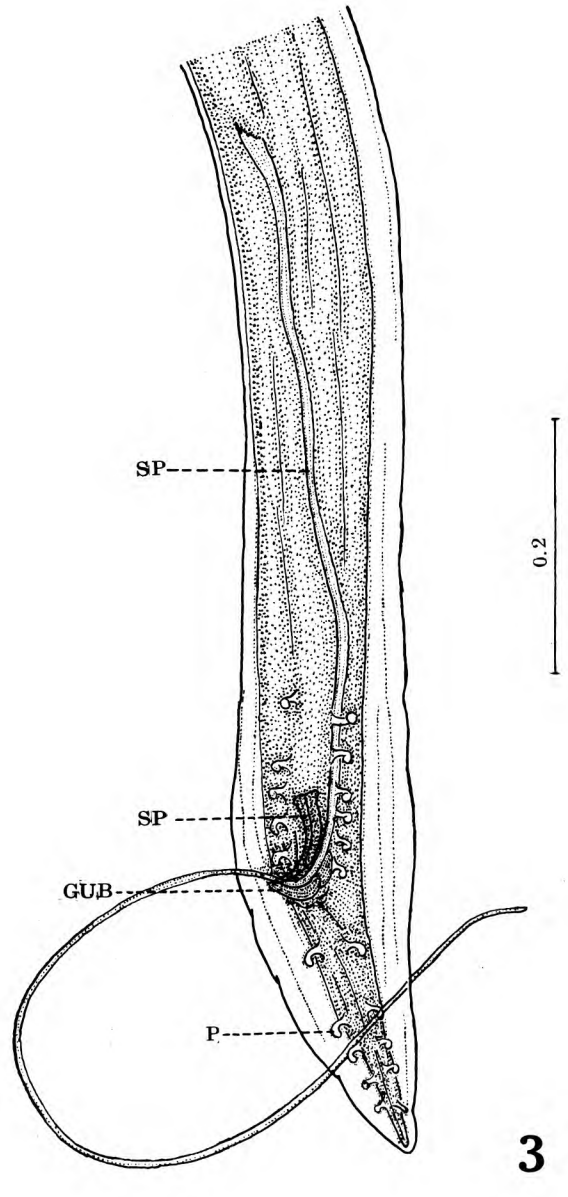
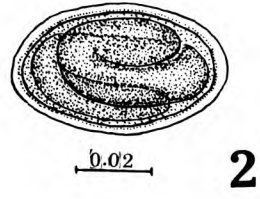
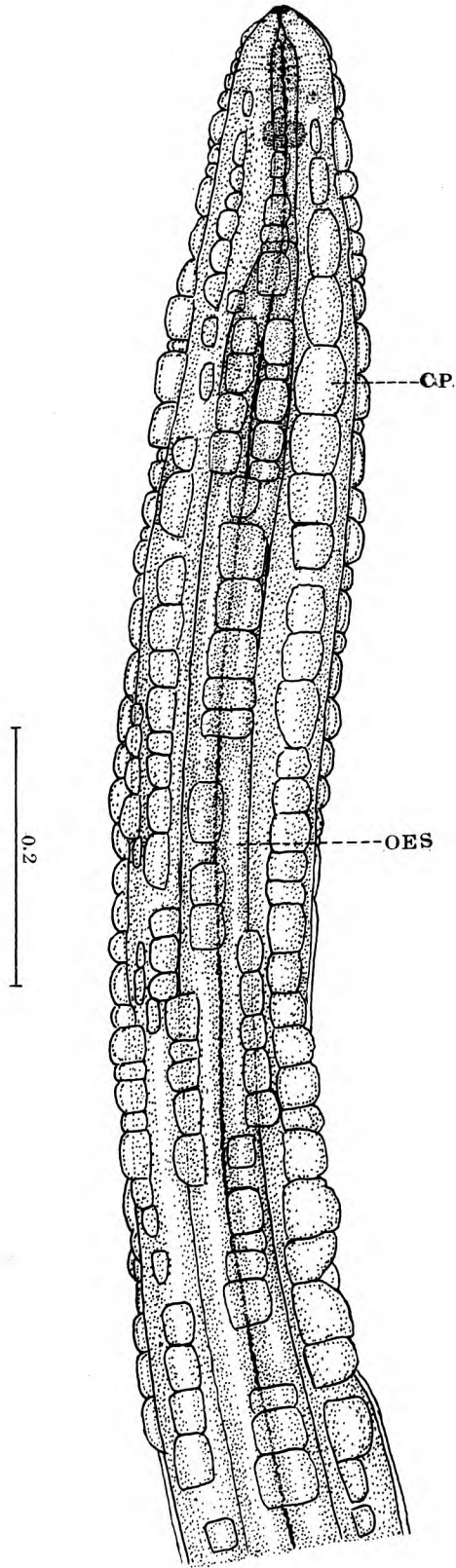
Gongylonema sp.

Fig. 1. Anterior end of female

Fig. 2. Embryonated egg

Fig. 3. Posterior end of male

PLATE II



A SURVEY OF THE HELMINTH PARASITES
OF SMALL MAMMALS IN THE VICINITY
OF MANHATTAN, KANSAS

by

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The economic and ecological importance of small mammals, especially of the orders Rodentia and Lagomorpha, as host animals for a wide variety of parasites and infectious diseases, has received an increasing and wide-spread interest in recent years among the many workers in these fields. While the material dealing with parasites has steadily become more extensive, there remains a prodigious amount of research yet to be conducted in order that a thorough investigation of the parasitic fauna may be completed.

An opportunity was presented at Kansas State College for a survey of the helminth parasites of small mammals as a result of an ecological study being conducted on mouse-like rodents by Drs. Gier and Tiemeier of the Kansas State Zoology Department. A considerable number of animals were trapped and were made available for helminthological study. Since no extensive survey of the parasites of rodents has as yet been undertaken in Kansas, it was felt that the availability of these animals, supplemented by the writer's own trapping yields, afforded an excellent opportunity to contribute to the knowledge of the helminth fauna of small mammals in Kansas.

Three hundred and fifty-six small mammals comprising 10 genera and 12 species of the order Rodentia, one species of Lagomorpha, and one species of Insectivora were examined for parasitic helminth infections. These animals, with the exception of the Lagomorphs and Sciurids, which were obtained in the field with the aid of a 22 calibre pistol, were

obtained through the use of the usual snap type mouse traps, baited with an oatmeal peanut-butter mixture. These traps were set in the runways or openings of burrows whenever possible, where they proved very effective.

Post-mortems were performed on the animals as soon after capture as possible. The alimentary tract, liver, kidneys, heart and lungs were excised and examined for helminth infection. Nematodes recovered were fixed in warm 70 per cent alcohol; cestodes in an alcohol, formaldehyde, acetic acid, glycerine and water solution; and trematodes in A.F.A.

Delafield's haematoxylin was found to be a very satisfactory stain for cestode and trematode toto-mounts, while nematodes were cleared in lacto-phenol and stored in glycerine.

Thirteen species of cestodes, nine species of nematodes and two species of trematodes were recovered and identified from the host animals obtained (Table 1.). Of the cestodes, six species were identified from the family Anoplocephalidae Fuhrmann, 1907; three species from the family Hymenolepididae Fuhrmann, 1907; two species from the family Taeniidae Ludwig, 1886; and two species from the family Dilepididae Fuhrmann, 1907. The nematodes identified constituted four species from the family Oxyuridae Cobbold, 1864; two species from the family Trichuridae Railliet, 1915; one species from the family Thelaziidae Railliet, 1916; one species of the family Spiruridae Oerley, 1885; and one species from the family Heterakidae Railliet and Henry, 1914. Two species of trematodes were

recovered and identified to genus from the families Dicrocoeliidae Odhner, 1910 and Brachylaemidae Joyeux and Foley, 1930. Several specimens of the nematode genus Gongylonema were recovered from the stomach walls of the prairie meadow vole Microtus ochrogaster ochrogaster Wagner, and the white-footed mouse Peromyscus maniculatus bairdii Hoy and Kennicott. These specimens are thought to constitute a new species as a review of the literature has revealed no mention of any species of Gongylonema as reported from these animals, and available descriptions of species recovered from rodents fail to coincide morphologically with the writer's material. The specimens are reported as Gongylonema sp. until such time as a more determinative diagnosis can be made.

Ecologically the trapping areas were divided into three habitats: grazing areas, consisting primarily of big and little blue stem; cultivated areas, including brome alfalfa pastures, sorghum and cut grain fields; and uncultivated lands containing a wide diversity of floral species. The greater number and variety of helminths were recovered from rodents in the blue stem grazing areas where these animals were found in abundance. The prairie meadow vole proved an excellent host animal, while the cottontail rabbit, Sylvilagus floridanus mearnsi Allen, the house mouse Mus musculus musculus Linnaeus, the white-footed mouse, and the Norway rat Rattus norvegicus Erxleben, were found to be moderately infected.

The significance, if any, of the ecological data obtained is difficult to determine, as the number of host animals

examined from these areas was hardly large enough to allow any conclusions concerning the presence of helminth species, their abundance and distribution in relation to the biotic, edaphic and physical factors exhibited in the trapping areas.